International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Effect of Quality of Chemistry Practical Work on Students' Performance in Chemistry in Public Secondary Schools of Machakos and Nairobi Counties in Kenya

John Thiongo Mwangi, PhD.

University of Nairobi, School of Education, Kenya

Abstract: ***The purpose of the study was to investigate the effect of quality of chemistry practical work on students' performance in chemistry in public secondary schools of Machakos and Nairobi counties in Kenya. Quality of chemistry practical work refers to the degree of learner involvement in the practical. The study describes and examines the effect of the quality of practical work implemented by secondary school chemistry teachers. The students' performance in chemistry was determined from scores obtained by students in Students Achievement Tests (SATs) done just before and immediately after exposure to different types and amounts of chemistry practical work in the topic under investigation. Descriptive and inferential statistics such as the mean and independent t-test were used to discuss the research findings. The study found that there is a positive relationship between the quality of practical work and learners' performance in chemistry. The results of the study indicate that the students had comparable performance in chemistry before treatment; that the quality of practical work had a significant contribution to the post test scores; and that there was a significant difference in performance in the post test between the experimental and control groups. The study recommends that the quality of chemistry practical work exposed to students be improved so as to improve performance in chemistry.***

Keywords: Chemistry, Performance, Quality of Chemistry Practical work and Students

1. Introduction

Practical work is an essential feature of secondary school science education (Abrahams & Millar, 2008), hence a high proportion of chemistry lesson time in secondary schools is given to practical work, with assumption that they lead to distinctive attainments in students. Although the practical approach is generally effective in getting students to do things with apparatus and materials, it is also seen as relatively ineffective in developing their conceptual understanding of the associated chemistry ideas and concepts. Barton (2004) reports that literature on practical work in school science indicates that there is no clear consensus about the relative merits of practical work and why we devote so much of our time and limited resources to it. Abrahams & Millar (2008) also report that questions have been raised by some science educators about the effectiveness of using practical work as a teaching and learning strategy.

Quality of chemistry practical work refers to the degree of learner involvement during chemistry practicals. That is, experiments in chemistry lessons are done by students individually, in pairs, in groups of five or in groups of more than five students. Most school chemistry curriculums specify that practical work and investigative activities must be carried out by students. However, there is a gap between policy and practice, between what is written in curriculum documents, what teachers say they do, and what students actually experience. Dillon (2008), states that, although the importance of practical work in school science is widely accepted, it is also important that the nature and quality of the practical work be supportive to learning. The quality of chemistry practical work varies considerably not just in the UK but elsewhere in the world (Lunetta, Hofstein & Clough, 2007). Also, Hodson (2001) found that chemistry teachers' stated lesson aims frequently failed to be addressed during actual lessons.

Despite curriculum reforms aimed at improving the quality of practical work, students spend too much time following recipes and, consequently, practicing lower level skills (Dillon, 2008). Similarly, where students only carry out instructions from worksheets to complete a practical activity, they are limited in the ways they can contribute. As a result, students fail to perceive the conceptual and procedural understandings that were the teachers' intended goals for the laboratory activities (Lunetta *et al*., 2007). This is a case of under utilisation of the opportunities provided by practical activities.

Strategies to improve the quality of practicals have been identified by many authors. For example, Millar, (2004) pointed out that, effective tasks are those where students are not only 'hands on' but also 'minds on' so that they can make the most of this learning experience. In Millar's opinion, improving the quality of practical activities would be to help teachers become much clearer about the learning objectives of the practical tasks they use.

For many students, what goes on in the laboratory in form of chemistry practical work is said to contribute little to their learning of chemistry or to their learning about chemistry and its methods (Millar, 2009). In a review of research on practical work in school science, Dillon (2008) reports that despite curriculum reform in UK aimed at improving the quality of practical work, students spent too much time following 'recipes' and consequently, practising lower level skills. These concerns have led to calls for more 'authentic'

practical experiences, or to re-think, re-evaluate, and perhaps reduce, the amount of practical work, to leave more room for other learning activities. Abrahams and Millar (2008) maintain that it is time for a reappraisal of the nature, and quality of practical work in the teaching and learning of chemistry.

2. Importance of the Quality of Chemistry Practical Work

Many studies have been conducted on the importance of practical work while teaching science. The role of practical work in science education has been detailed by some researchers (Lazarowitz & Tamir, 1994; Lunetta, 1998). Currently, science educators and teachers agree that practical work is indispensable to the understanding of science. The main purpose of practical work in science education is to provide students with conceptual and theoretical knowledge to help them learn scientific concepts, and through scientific methods, to understand the nature of science. Practical work also gives the students the opportunity to experience science by using scientific research procedures. In order to achieve meaningful learning, scientific theories and their application methods should be experienced by students.

Like other sciences, chemistry teaching and learning is supported by laboratory practical work (Reid & Shah, 2007). Chemistry practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract (Lagowski, 2002). Reports emphasize that teaching science with the help of practical work makes science to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture (Hofstein, 2004). Students have a lot to benefit from practical work which may include increasing students' interest and abilities in chemistry as well as their achievement in chemistry (Pavesic, 2008). Reports emphasize that teaching science with the help of practical work makes science to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture (Hofstein, 2004).

Good quality practical work gives students an opportunity to engage in deep learning (Gunstone & Champagne, 1990). Using quality practical work provides an opportunity of identifying the main objectives of the work and in planning and executing it, of identifying the conceptual and practical difficulties encountered, recording and discussing the results and observations and of suggesting practical alterations and improvements (Teixeira-Dias, Pedrosa de Jesus, Neri de Souza & Watts, 2005). The latter, thus, could result in a significant positive impact on a students' ability to learn both the desired practical skills and also the underlying theory. Likewise, if teachers do not select appropriate practical work, may result in practical work of doubtful quality leading to an approach that is de-motivating for students and a poor use of teaching resources and probably end up with poor performance in the subject.

3. Objectives of the Study

The study sought to achieve the following objectives:

1) To establish students' performance in chemistry in the pre-test.
2) To examine the effect of the quality of chemistry practical work on students' performance in secondary school chemistry.
3) To find out if there was a significant difference between the experimental and control groups in the performance of the post test.

4. Research Methodology

The research was conducted using quasi experimental of the pre- test – post test design. The quasi-experimental approach of the pre-test – post test design was suitable for this study because the performance in chemistry of students taught using class experiments method involving less than five (< 5) students per group, (experimental group) was compared to the performance in chemistry of the students taught using teacher demonstration method involving the whole class as a group (control group). Student Achievement Tests (SATs) were used to test learners' performance in chemistry. In both groups a pre-test and a post- test was used to determine the performance of the groups before and after treatment. The use of either class experiment or teacher demonstration methods in teaching of the chemistry topic was done without affecting the classroom set up so that the learners were not aware of their involvement in the study. Multi-stage cluster sampling and purposive sampling were used to obtain a sample of 438 Form Two students from 16 public secondary schools in Machakos and Nairobi counties for this study. The data for this study were collected using student achievement tests (SAT) – that is, the Pre-test and the Post test.

Student academic achievement in both the experimental and control groups used in the study was evaluated using the researcher created chemistry student achievement tests (SAT). Two student achievement tests: a pre-test and a post-test, were constructed and used by the researcher. Pre-tests are administered as formative evaluations to assess student pre-treatment chemistry academic abilities (Creswell, 2005). A post test is administered as summative assessment after every treatment period to measure student academic gain in chemistry (Ormrod, 2003). The topic was conveniently chosen because it is normally taught to form two classes at that time of the school calendar and which was also the chosen time of the study. This did not inconvenience teachers during their planning process and also the learners were not aware of their involvement in the study. The tests consisted of questions that were of knowledge, comprehension and application levels while a few were of the analysis level in Blooms taxonomy of objectives. Performance of the students was based on the scores attained after marking the achievement tests. The data obtained was analysed and reported using descriptive and inferential statistics.

5. Findings and Discussion

The findings of the study were discussed as per each objective.

Research Objective 1

Objective one sought to establish students' performance of the experimental and control groups before treatment. The findings are presented in Tables 1 and 2.

Table 1: Pre-Test Scores of the Experimental and Control Groups

Test type	Student Group	N	Mean	Std. Deviation
Pre Test	Experimental	254	13.47	5.37
	Control	184	13.40	5.36

Table 1shows that in the pre-test, the groups' mean score were almost equal (a difference of 0.07) implying that the two groups of students were at the same level of performance in chemistry before the treatment was done. The results in Table 2 below, shows the findings of the t-test analysis of the pre-test scores of the experimental and control groups.

Table 2: t-Test Results on Pre–Test Scores between Experimental and Control Groups

Independent T test		T	DF	Sig. (2-tailed)	Mean Difference
Pre-Test	Equal variances not assumed	4.02	688.73	.17	0.07

The information in Table 2 shows a t value of 4.02; $p > 0.05$, implying that the observed difference in pre-test mean scores of 13.47 and 13.40 between the experimental and control groups respectively before treatment was not significant. This indicates that the two groups of students were similar in chemistry achievement before the treatment was done.

Research Objective 2

Objective two sought to examine the effect of the quality of chemistry practical work on students' performance in secondary school chemistry. The information is presented in Table 3.

Table 3: Post-test Performance of Learners in Experimental and Control Groups

	Test type	N	Mean	Std. Deviation
Post Test	Experimental	254	15.41	4.28
	Control	184	14.20	4.57

The findings presented in Table 3 shows that the experimental group's mean score is higher than the control group's mean score by a value of 1.21, implying that the treatment, that is, the use of class experiments of less than five students per group had a positive effect on students' performance in chemistry. The higher mean observed in experimental groups compared to that of the control groups suggests that students in the former understood the chemistry concepts and performed better than those taught using teacher demonstration for the whole class. The results corroborate the studies done by Abrahams & Millar (2008), and observations made by (Lagowski, 2002) and (Reid & Shah, 2007).

Research Objective 3

Objective three sought to find out if there was a significant difference in performance of the chemistry post-test between the experimental and control groups. The results are presented in Table 4.

Table 4: t-Test on the Post-Test between Experimental and Control groups

Independent t- test		t	DF	Sig. (2-tailed)	Mean Difference
Post-Test	Equal variances not assumed	4.47	577.34	.00	1.55

The data in Table 4 shows that the t value of the post test is 4.47; $p < 0.05$, indicating that there was a significant difference between the post-test mean score in chemistry of students in the experimental group and those in the control group. This indicates that students taught using the class experiment method performed better than those taught using the teacher demonstration method. This implies that performance in secondary school chemistry improves when the quality of the practical work used in teaching is improved. This is in agreement with Gunstone and Champagne, (1990) who reports that good quality practical work gives students an opportunity to engage in deep learning that leads to higher achievement in chemistry.

6. Conclusions and Recommendations

6.1 Conclusion

The study found that students taught using class experiments involving groups consisting of five or less students performed better than those taught using teacher demonstration consisting of the whole class or large groups. Results showed that the quality of chemistry practical work has a significant positive effect on learners' performance in secondary school chemistry. This implies that there is a positive linear relationship between the quality of practical work and learners' performance in secondary school chemistry. Therefore, the quality of practical work should be considered when teaching and learning chemistry. That is, consistent planning and use of quality practical work by teachers should take place if the students' performance in chemistry is to improve. That is, teachers should have a tacit knowledge of how to do practical work themselves. The findings confirm that the use of good quality practical work is an effective way of improving learners' performance in secondary school chemistry.

6.2 Recommendation

The study recommends that the quality of chemistry practical work be considered when planning and teaching secondary school chemistry in Kenyan public secondary schools.

References

[1] Abrahams, I. & Millar, R. *(2008).* Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education.* 30.14: *1945-1969*.
[2] Barton, R. (2004). *Teaching secondary science with ICT*. Berkshire, England: Open University Press.
[3] Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and*

qualitative research (2nd ed.). Columbus, OH: Pearson – Merrill Prentice Hall.

[4] Dillon, J. (2008). *A review of the research on practical in school science*. London: Kings College.

[5] Gunstone, R.F. & Champagne, A. B. (1990). *Promoting conceptual change in the laboratory.* In E. Hegarty-Hazel (Ed.). The student laboratory and the science curriculum London: Routledge.

[6] Hodson, D. (2001). Chemistry practicals in science: Time for a reappraisal. *Studies in Science Education,* 19, 175-184.

[7] Hofstein, A. (2004). The laboratory in chemistry education: Thirty years of experience with developments, implementation, and research. *Chemistry Education: Research and Practice, Vol. 5, No. 3, pp. 247-264*. Published Online.

[8] Lagowski, J. J. (2002)The role of the laboratory in chemical education. Retrieved from http://www.utexas.edu/research/chemed/lagowski/jjl_beijing_02.pdf (Accessed on 15th Aug, 2015).

[9] Lazarowitz, R. & Tamir, P. (1994). *Research on using laboratory instruction in science*. In L. Gabel (Ed.), Handbook of research on science teaching and learning (pp. 94–128). New York: Macmillan.

[10] Lunetta, V.N. (1998). *The school science laboratory: Historical perspectives and centers for contemporary teaching*. In: B.J. Fraser & K.G. Tobin (Eds), International handbook of science education. Dordrecht. Kluwer Academic Publishers.

[11] Lunetta, V. N., Hofstein, A., & Clough, M. P. (2007). *Teaching and learning in the school science laboratory*. An analysis of research, theory, and practice. In, S. K. Abell and N. G. Lederman (Eds), Handbook of Research on Science Education (pp. 393–431). Mahwah, NJ: Lawrence Erlbaum Associates.

[12] Millar, R. (2009*). Analysing practical activities to assess and improve effectiveness: The Practical Activity Analysis Inventory (PAAI)*. York: Centre for Innovation and Research in Science Education. University of York. Available from http://www.york.ac.uk/depts/educ/research/ResearchPaperSeries/index.htm

[13] Millar, R. (2004). *The role of practical work in the teaching and learning of science. High school science laboratories: role and vision.* Washington, DC: National Academy of Sciences.

[14] Ormrod, J. E. (2003). *Educational psychology. Developing learners (4th ed.).* Columbus, OH: Merrill Prentice Hall.

[15] Patton, M. Q. (2002). Qualitative Research and Evaluation Methods. California: Sage Publication, Inc.

[16] Pavesic, B. J, (2008). *Science achievement, gender differences, and experimental work in classes in Slovenia as evident in TIMSS studies*. Studies In Educ. Evaluat. 34: 94-104.

[17] Reid, N. & Shah, I. (2007). The role of laboratory work in university chemistry. *Chemistry Education Research and Practice;* 8 (2), 172-185.

[18] Teixeira-Dias, J. J. C., Pedrosa de Jesus, M. H., Neri de Souza, F. and Watts, D. M. (2005). Teaching for quality learning in chemistry, *International Journal of Science Education* 27(9), 1123-1137.